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(54) Offshore mooring and loading system

(57) An offshore mooring and loading system comprises a dynamically positioned vessel (1) and at least two flexible elements, such as hoses (25, 25'), or a hose and a chain extending in opposite directions from two spaced apart locations. The hose extends up to a disconnectable coupling (12) provided at an outboard extending arm (3), the lower part of which has buoyancy and the upper part is in the form of a driven turntable (10, Fig 3, not shown). The arm (3) can be swung inboard. A swivel (13) is provided at the top of the turn-table (10).

Fig-1

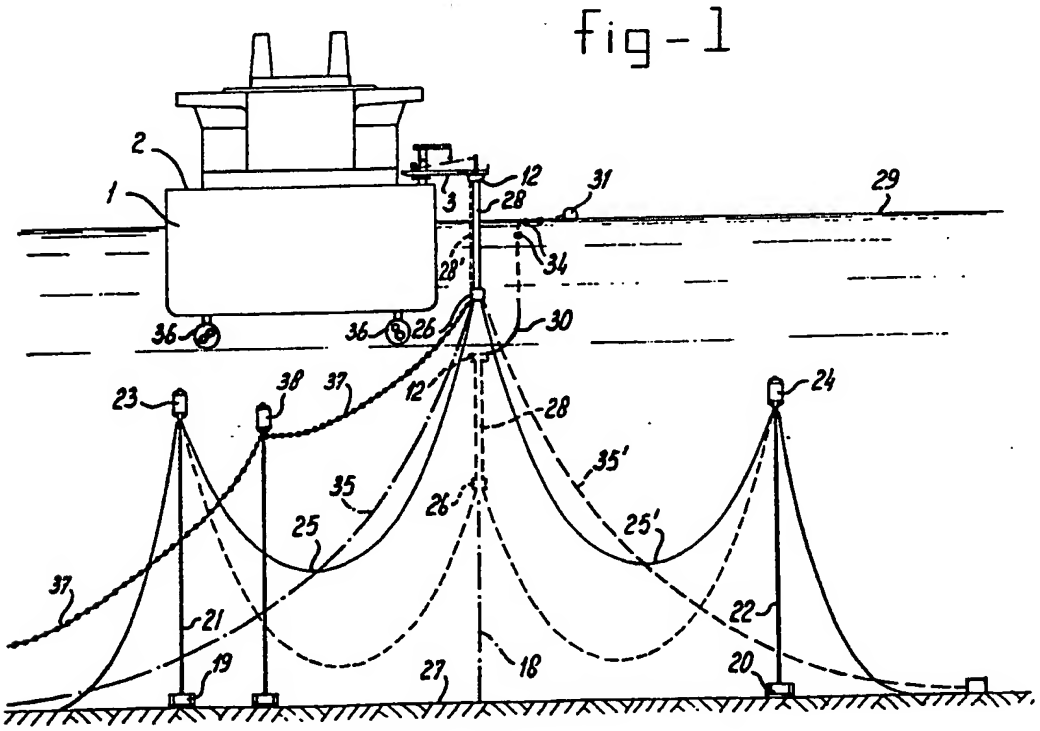

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fig-1

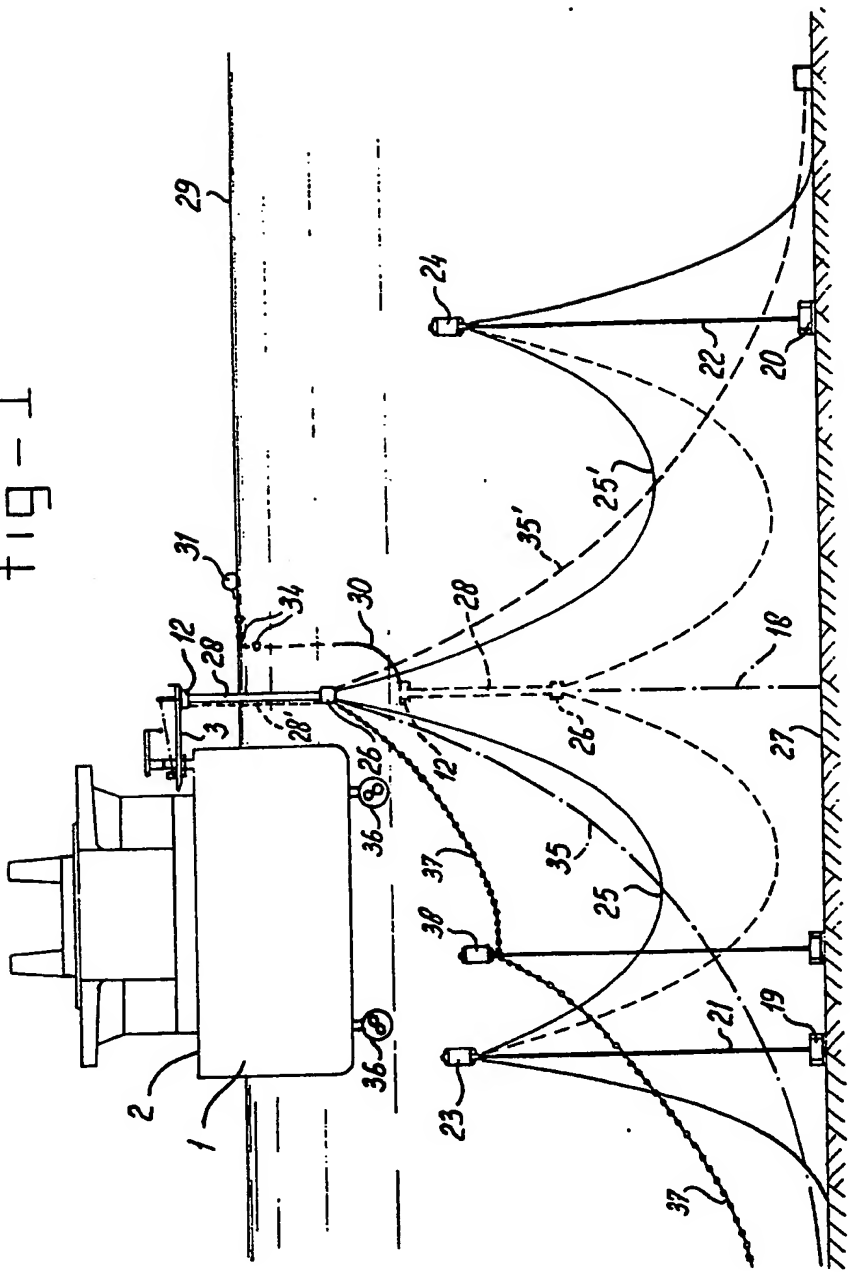
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fig-2

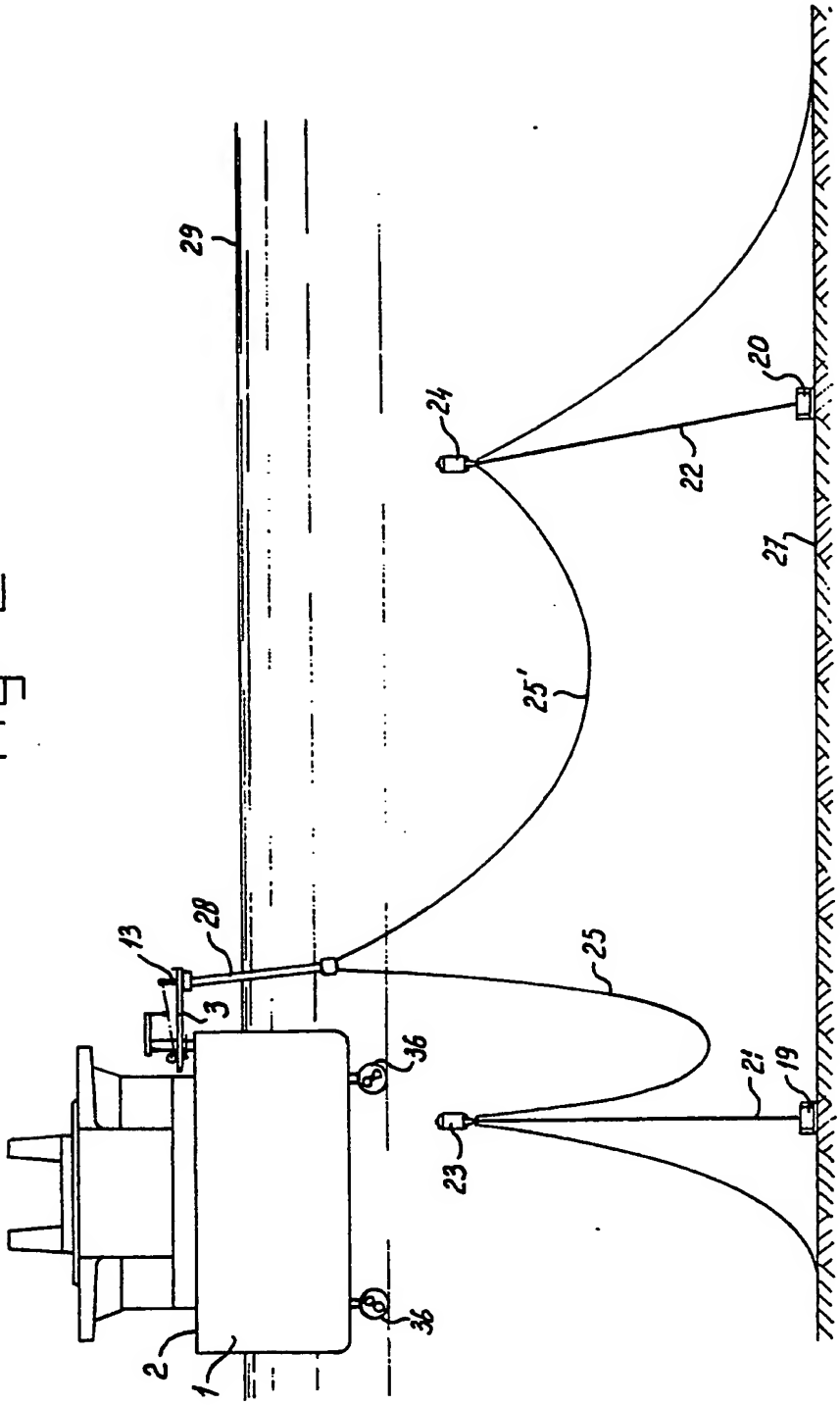


Fig - 3

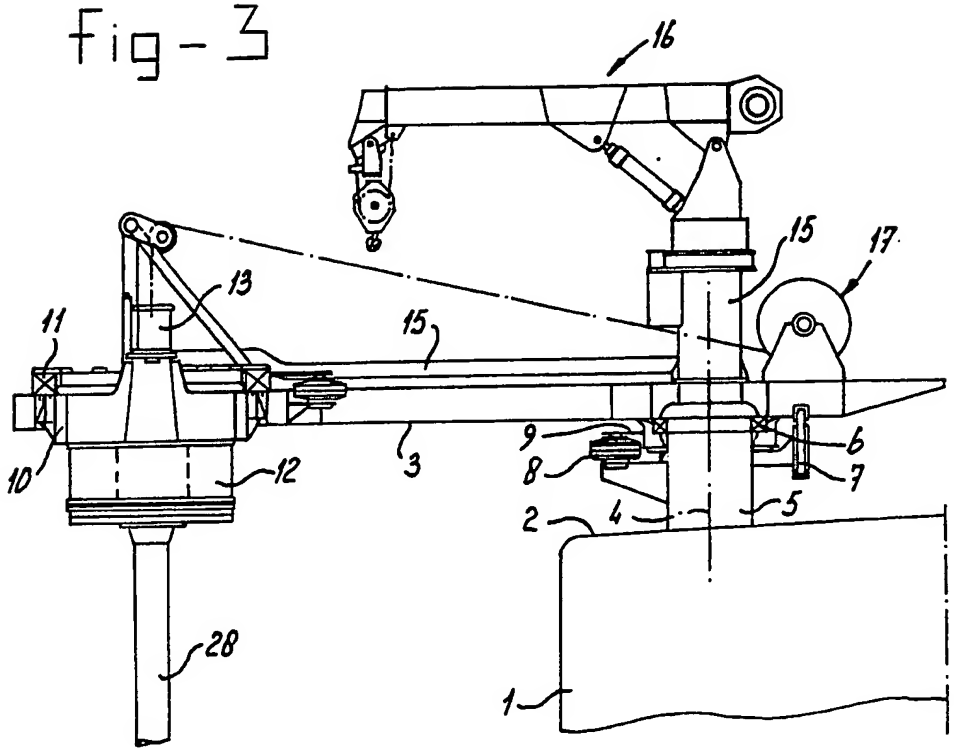


Fig - 4

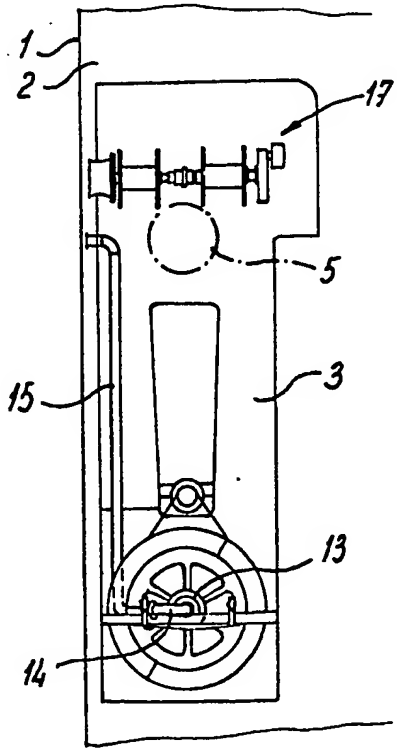
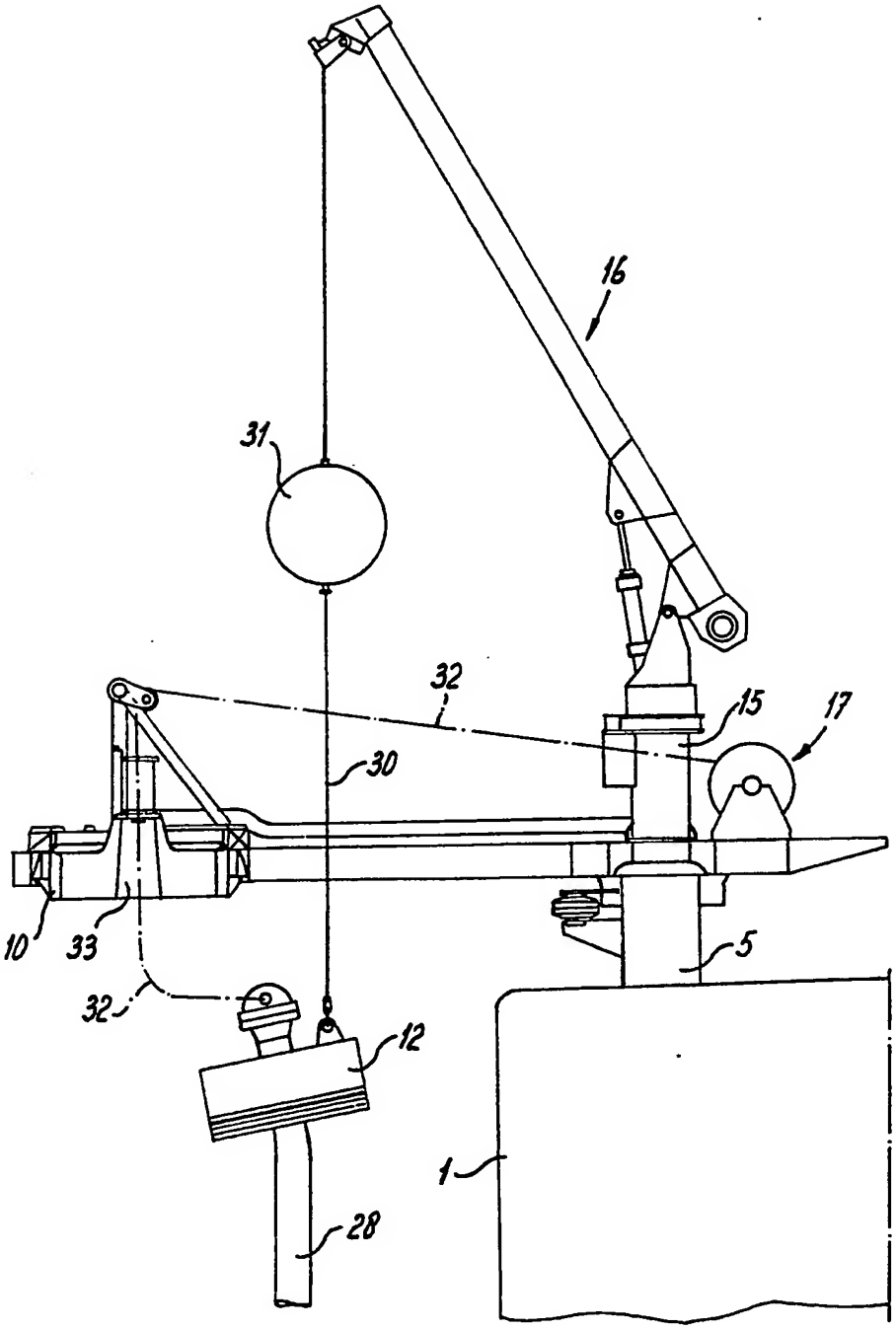


Fig - 5



OFFSHORE LOADING SYSTEM

The present invention relates to an offshore loading system comprising a floating device with an outward extending arm carrying a swivel and the fluid connections from the swivel towards the floating device, a turn table rotatably supported by the outer end of the said arm, a quick action coupling situated at the turn table, the disconnectable reconnectable part of which having buoyancy, a hose extending downwards from the disconnectable part of the coupling towards a location at or near the water bottom, according to a catenary configuration.

The invention more in particular, but not exclusively, relates to a loading system in which the hose extends towards the said location at or near the water bottom according to a double catenary configuration obtained by a buoyancy device attached to the hose at a point between the coupling and the said location.

An offshore loading system of this type is known e.g. from US Patent Reissue 32578 which is a Reissue of US Patent 4490121.

From this patent an offshore loading system is known in which the anchoring of the vessel and the connection of the hose or hoses with a location at the water bottom are combined. The vessel has a rigid arm at the bow carrying the swivel and associated pipe lines and carrying below the arm, through the intermediance of a universal joint, the two parts of a quick action

coupling of which the upper part in the disconnected mode remains connected to the vessel and of which the lower part in the disconnected mode moves at or below water level. The hose or hoses are connected to the lower end of said disconnectable part and held in a double catenary fashion by means of a buoyancy device. Moreover said disconnectable part has anchor chains connected thereto which extend in different directions, thereby mooring the vessel when in connected mode and also mooring the disconnectable part after disconnection has taken place. Said disconnectable part has been provided with a pick-up line and float. In the disconnected mode said coupling has to carry the weight of the anchor chains that are designed for anchoring a tanker and accordingly have weights which are out of proportion when compared to the dimensions of the disconnectable part of the coupling, whose dimensions, although not small, could be considerably reduced if it were not necessary to give that part sufficient buoyancy to carry the chains.

In arctic areas it sometimes is necessary to have an offshore loading system which allows for immediate removal of the floating device, such as a tanker. Therefore the system should not be extremely heavy, at least with respect to the disconnectable part, which in disconnected mode has to move below water level. Moreover, a small weight is easier to lift when the mooring system has to be reconnected.

A reduction in weight is obtained by removing the anchor chains but this would not be the total solution because the hoses could be subjected to large movements, sharp bends and high tension forces.

The purpose of the invention is to obtain an offshore loading system which has the means to avoid these undesirable effects.

According to the present invention an offshore loading system comprises a floating device with an outward extending arm carrying a swivel and the fluid connections from the swivel towards the floating device, a turn table rotatably supported by the outer end of the said arm, a quick action coupling situated at the turn table, the disconnectable reconnectable part of which having buoyancy, a hose extending downwards from the disconnectable part of the coupling towards a location at or near the water bottom, according to a catenary configuration, and including at least two flexible elements, extending (in opposite directions) away from each other from locations on opposite sides of a centre line through the coupling in the non-displaced position of the floating device, said two elements being connected to the water bottom, the floating device being of the dynamically positioned type, and the turntable at the end of the arm being provided with a drive system adapted to rotate the turntable about its vertical axis.

A dynamically positioned vessel or the like floating device allows, if desired, a reasonably precise means of staying on location even with wave heights of 5 to 8 metres, but also allows considerable displacements if for example floating ice of a possibly dangerous size is to be avoided.

If only one hose, or one set of hoses which extend side by side is used, the other flexible element or elements can be a chain or chains extending in directions which

are oriented away from the direction of the hose or set of hoses.

By arranging the hose and the chains in accordance with balanced catenary configurations the coupling is centred to a known position when in the disconnected mode.

Due to the fact that the floating device is of the dynamically positioned type, the chains need not and do not have a function in anchoring said device.

At least two of the flexible elements, if not all, are hoses extending preferably in opposite directions with each hose extending according to a double catenary configuration which is obtained by means of a buoyance device attached to the water bottom by a cable or the like connected to an anchor.

Consequently anchor chains are avoided and the disconnectable part of the coupling is no longer required to be designed to be capable of carrying the weight of said chains in the disconnected mode.

To carry a hose by means of a float between a coupled point and a location at the water bottom is well known in itself. By locating two hoses or more in a manner opposite each other, so that a kind of symmetry is obtained with respect to the central position of the coupling and by providing said hoses with floats, which floats keep each hose in its double catenary fashion, with an anchor cable which extends downwardly to an anchor at the water bottom, a symmetrical centralising situation is obtained for the coupling in its disconnected mode so that, if disconnection occurs, the coupling will always move towards a submerged known

position between the floats. By said means, however, it is also possible during operational connected mode to provide for a large degree of flexibility, allowing the tanker to move reasonably far away from its central position if circumstances would require this.

This holds true as well in the case that there is only one hose and one or more chains extending in different directions, because said hose and chains or the like even when arranged in a single catenary configuration will centralise a disconnected coupling and also allow a large area within which the floating device may keep its position without overstressing the flexible elements. It should also be noted that in both connected and disconnected modes if the hoses are in a central known position, which is predetermined and calculated, no undesirable motions or forces can act on the hoses to cause possible damage or rupture and consequently an oil spillage.

After disconnection the central position of the submerged coupling part facilitates the reconnection, in particular if no pick-up line with float is used or said pick-up line would be destroyed, e.g. by ice.

The circular bearing of the coupling has a frictional resistance which is larger than the torsional resistance of the hoses. Because of the absence of a rigid connection between the hoses and the sea bottom no anchored restraint against torsion can be made so that during weathervaning operations the hose or hoses could be turned out of position and subjected to torsion. Therefore the turntable of the outward extending arm possesses a drive system of sufficient power to block

the flexible elements in an earth bound position when the floating device weathervanes.

The drive system of the turntable can be activated manually but it is preferred to provide for a control system which is logically integrated into the tanker dynamic control positioning system.

A rigid arm at the bow of the vessel which forms the floating device is well known.

Said arm extends above water level, but could also be an arm below water level.

The arm may be rotatably mounted in a pedestal and means are provided to swing the arm inboard and outboard respectively as well as means to lock the arm in either one of said positions.

Said arm can be mounted at the bow or the opposite end of the vessel, but preferably is substantially mounted upon the deck in the middle of one side of the floating device. This is a location where the movements of the vessel, in particular the pitch motions are small so that the downward extending hoses are subjected to less movements and accordingly less forces when the vessel rides on the waves.

The possibility to swing the arm inboard is of importance for ease of maintenance, in case the vessel has to sail away and during harbour activities. It is known to provide the disconnectable part of the coupling with a pick-up line.

Because the invention has resulted in the buoyant capacity of the disconnectable part of the coupling becoming considerably smaller a problem arises if the hoses are filled up with a heavy or a light liquid. If the heavy liquid, such as water, prevails then the coupling will move further downward than in the case when oil prevails.

The pick-up line may have a series of additional floats which come into function as soon as the disconnected coupling tends to sink too deep.

The disconnectable buoyant part of the coupling may carry a weight, by means of a cable which preferably positions the weight far below water level allowing the hose connection to said weight preferably by means of transverse passageways through the weight.

Between said weight and the disconnectable part of the coupling separate hoses may extend. A flexible light-weight disconnectable part is obtained in this way which takes care that the hoses, which extend away from said weight towards the spaced apart locations, cannot come into conflict with the floating device.

The invention will now be described by way of example only with reference to the five figures of the accompanying drawings in which:-

Figure 1 shows the system of the invention in the ideal central position

Figure 2 corresponds to Figure 1 and shows the system in case the vessel is displaced

Figure 3 is a detailed view from one side of the arm

Figure 4 is a top view of the arm in the inboard swung position

Figure 5 shows in a view similar to Figure 3 the reconnection procedure

Figures 1 and 2 show a tanker (1) which can be held in place by dynamically positioning means (35).

Said tanker has on deck (2) near one side board an arm (3) which is pivotably mounted about a vertical axis (4) (Fig.3) on a pedestal (5) by means of a bearing (6). Said arm (3) can be swung from the inboard position shown in Fig.4 towards the outboard position shown in Fig.3 and 5 and locked in place by means of a pin (7).

The swinging movement of the arm (3) inboard and outboard respectively is performed by means of a hydraulic motor (8) and a chain drive (9).

At the outer end of the arm a turntable (10) is provided supported in said arm by means of bearings (11).

Bearing (6) as well as bearing (11) preferably are axial- radial bearings.

Said turntable (10) forms part of the disconnectable coupling formed by the turntable (10) and the disconnectable part (12). The means for connecting and disconnecting are not shown, but are known in the art (vide e.g. Coppens et.al 4490121).

At the top of the turntable a swivel (13) has been provided from which pipes (14,15) extend towards the vessel (Fig.4).

Above the pedestal (5) the arm has been provided with a column (15) carrying a crane (16) (Fig.3 and 5).

The arm further carries winch means (17).

Fig.1 shows the ideal position of the vessel with the quick-action coupling (10,12) in line with the vertical centre line (18) located between anchors such as (19) and (20) which by means of anchor lines (21,22) are in connection with buoyancy devices (23,24) located on opposite sides of said centre line. Said buoyancy devices keep the anchor lines (21,22) under tension and carry hoses (25,25) according to a first catenary line between a weight (26) suspended from the coupling (12) and according to a second catenary line towards not shown locations on the bottom (27) of the body of water.

Instead of the hoses (25,25) it is possible as well to use a single hose extending according to a single catenary line indicated in Fig.1 by a dotted line (35), combined with a chain extending in opposite direction according to a catenary line indicated by an interrupted line (35) in Fig.1.

It of course could be possible to give the chain or chains respectively a double catenary line configuration (37) as well by means of floats such as (38).

The weight (26) is suspended from the disconnectable coupling part (12) by means of a cable (28) or otherwise. Between said weight (26) and the coupling part hoses (28) extend.

In the disconnected position, shown with interrupted lines in Fig.1, the disconnected coupling part (12) with hoses (28) and weight (26) will be below the surface (29) of the body of water, preferably far below it and below the bottom of the vessel (1), and due to the weight of the hoses (25,25) and the clear positioning of the buoyancy devices (23,24) be centralised with respect to the anchors (19,20).

In the connected position a considerable displacement of the tanker (1) is possible without the hoses being harmed.

It will be clear from comparing Fig.1 and 2 that if in the position shown in Fig.2 disconnection occurs the disconnected part with hoses (25,25) will automatically move into the position shown with interrupted lines in Fig.1.

The disconnectable part (12) of the quick-action coupling has been provided with a pick-up line (30) and a float (31). Reconnection can take place as shown in Fig.5 by picking up the float (31), lifting the buoyant part (12) of the coupling above water level, connecting to it a cable (32) and drawing the coupling part (12) by means of winch (19) and cable (32) into the opening (33) of the turntable (10).

As compared to the prior art construction the assembly of coupling part (12), hoses (28) and weight (26) is of a weight which is and can be relatively light and accordingly it is of great influence whether the contents of the hoses (25,25) are heavy or light.

To take care that in case heavy contents prevails and the submergable parts do not move too deep additional floats (34) are provided which increase the buoyancy of the disconnected part of the coupling.

CLAIMS

1. Offshore loading system comprising a floating device with an outward extending arm carrying a swivel and the fluid connections from the swivel towards the floating device, a turntable rotatably supported by the outer end of the said arm, a quick action coupling situated at the turntable, the disconnectable reconnectable part of which having buoyancy, a hose extending downwards from the disconnectable part of the coupling towards a location at or near the water bottom, according to a catenary configuration, and including at least two flexible elements, extending (in opposite directions) away from each other from locations on opposite sides of a centre line through the coupling in the non-displaced position of the floating device, said two elements being connected to the water bottom, the floating device being of the dynamically positioned type, and the turntable at the end of the arm being provided with a drive system adapted to rotate the turntable about its vertical axis.

2. Offshore loading system as claimed in Claim 1, in which at least two of the flexible elements are hoses extending (in opposite directions) away from each other, each hose extending according to a double catenary configuration obtained by means of a buoyancy device attached to each hose as well as to an anchor at the water bottom by means of a (cable or the like) separate substantially vertical connection means, such as a cable.

3. Offshore loading system as claimed in Claim 1, in which one flexible element is a hose and the other or others is or are chains respectively or the like and in which the said hose and each chain extend according to a double catenary configuration obtained by means of a buoyancy device attached to the hose as well as to each chain, said buoyancy device having a substantially vertical connection with an anchor at the water bottom.

4. Offshore loading system as claimed in Claim 1 in which one flexible element is a hose and the other or others is or are respectively chains (or the like) and in which the said hose extends in a double catenary configuration obtained by means of a buoyancy device attached to said hose as well as to an anchor at the water bottom by means of a substantially vertical connection and the said chain or chains extends or extend respectively in a single catenary configuration towards a location at or near the water bottom.

5. Offshore loading system as claimed in any preceding claim in which the outwardly extending arm is above sea level, the arm being rotatably about a vertical axis mounted in a pedestal and means being provided to swing the arm inboard and outboard respectively as well as means to lock the arm in either one of said positions.

6. Offshore loading systems as claimed in Claim 5 wherein the arm is substantially mounted upon the deck in the middle of one side of the floating device.

7. Offshore loading system as claimed in any preceding claim in which the disconnectable part of the coupling is provided with a pick-up line and a float, and in

which the pick-up line is provided with a series of additional floats.

8. Offshore floating device as claimed in any preceding claim wherein the disconnectable buoyant part of the coupling carries a weight by means of a cable, the flexible elements being connected to the weight and separate flexible elements extending from the weight upwards towards the coupling.

9. Offshore floating device substantially as hereinbefore described with reference to Figures 1 to 5 of the accompanying drawings.

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